

50,  
COMPARISON OF WHOLE PLANT GRAIN SORGHUM SILAGE, GRAIN SORGHUM  
HEAD-CHOP SILAGE, AND SORGHUM GRAIN IN RATIONS FOR LACTATING COWS

by

MOSES TIMOTHY DAURA

B. S., University of Zambia, 1977

-

---

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

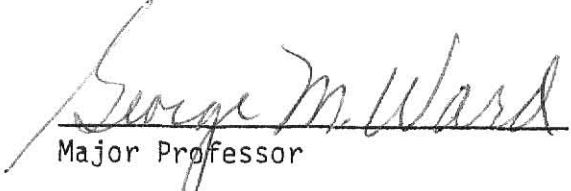
MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1980

Approved by:

  
Major Professor

**THIS BOOK  
CONTAINS  
NUMEROUS PAGES  
WITH THE ORIGINAL  
PRINTING BEING  
SKEWED  
DIFFERENTLY FROM  
THE TOP OF THE  
PAGE TO THE  
BOTTOM.**

**THIS IS AS RECEIVED  
FROM THE  
CUSTOMER.**

Spec. Coll.  
LD  
2668  
.T4  
1980  
D38  
c.2

## TABLE OF CONTENTS

	page
LIST OF TABLES . . . . .	iii
ACKNOWLEDGEMENTS . . . . .	iv
INTRODUCTION . . . . .	1
LITERATURE REVIEW . . . . .	2
EXPERIMENTAL PROCEDURE . . . . .	9
RESULTS AND DISCUSSION . . . . .	12
SUMMARY AND CONCLUSIONS . . . . .	22
LITERATURE CITED . . . . .	24

## LIST OF TABLES

Table	page
1. Proximate analyses of the sorghum feeds . . . . .	13
2. Composite proximate analyses of the rations . . . . .	14
3. Weight gains and milk production . . . . .	15
4. Feed-to-milk ratios . . . . .	17
5. Composition of milk . . . . .	18
6. Analyses of variance of milk production and body weight change . . . . .	19

## ACKNOWLEDGEMENTS

The author wishes to express his sincere thanks for the guidance and support he received from his major professor, Dr. George M. Ward. He also wishes to thank the members of his committee: Drs. Jack G. Riley and Gerry L. Posler for their help and constructive criticism.

To Dr. Arthur D. Dayton, special thanks for the assistance in statistical analysis of the data. Appreciation is also expressed to Bill Carinder and Mary Kay Schmidt for their help in this study.

The author feels in debt to Joseph M. Mothopi for his help in typing this manuscript and for being such a good friend.

To Salvador J. Cordova and Mohammed Kazemi, thanks for the encouragement.

## INTRODUCTION

Grain sorghum can be grown in arid and wet climates, making it a dependable feed crop in variable rainfall areas of the world. The development of improved varieties and hybrids made grain sorghum a prominent crop in the United States. In Kansas it is the predominant grain produced for livestock feed. The increase in sorghum production in the state has a direct relation to the growth of the cattle industry.

Sorghum grain is widely used as a major energy source in dairy cow rations because it is often the most economical. Since grain comprises a large part of the feed cost for dairy cows, it is important to identify methods for harvest and feeding which yield the greatest return.

In this study production responses of dairy cows - milk production, cow weight changes and milk components (dry matter, fat, protein, ash, and lactose) - were evaluated to determine the most efficient method for harvest and feeding grain sorghum. The treatments compared were: (1) dry grain, rolled, (2) head-chop silage, and (3) whole plant silage.

## LITERATURE REVIEW

Culture of grain sorghum began in Africa in pre-historic times, however, recorded history traces grain sorghum's origin to the Middle East around 700 B. C. In the United States grain sorghum production developed following introduction of the durras from Egypt in 1874 and kafirs from South Africa in 1871. Wall and Ross (1970) reported other important introductions, pink kafir from South Africa about 1905 and feterita and hegari from Sudan in 1906 and 1908, respectively.

Sorghums are a popular grain crop in low rainfall areas because of their drought resistance. The original varieties were tall, but dwarf (combine) types, made possible by many years of breeding and selection, are preferred.

In variable rainfall areas where drought often causes a poor corn crop, grain sorghums are a dependable feed crop. Browning and Merwine (1966) reported good grain sorghum silage yields and consistent quality in years of poor rainfall. Drought resistance contributes to the growing popularity of grain sorghum. In Texas it is the number one grain crop. In 1977, Kansas led the nation in grain sorghum production, but Texas was back in the lead in 1978 (Duitsman, 1978). Other major sorghum producing states include Oklahoma, Missouri, New Mexico, Arizona, South Dakota, Colorado, Nebraska, and California.

The feeding values of grain sorghum silage and corn silage have been compared frequently. The results favor corn silage (Good et al., 1921, La Master and Morrow, 1929, Cunningham and Reed, 1927, Nevens and Kendall, 1954, and Owen et al., 1961). However, Browning and

Lusk (1966) found that combine-type grain sorghum was as good as excellent corn silage in supporting daily fat corrected milk (FCM) production, though digestion coefficients for dry matter and gross energy favored corn silage. La Master and Morrow (1929) concluded that forage sorghum was 72 percent as efficient as corn for milk production. This conclusion was in agreement with one reached earlier (72 percent as efficient) by Good et al. (1921) who compared forage sorghum silage to corn silage on a pound for pound basis for fattening steers. However, when yields and quality of the two crops were considered, forage sorghum was found to be 92 percent as economical as corn. Cunningham and Reed (1927) and Nevens and Kendall (1954) reported only a slight advantage in milk production for corn silage over forage sorghum silage.

Animal production from silage or any other forage depends on its digestibility, the quantity consumed by the animal, and the efficiency of utilization of the digested fraction by the animal. Intake of silage dry matter is related to the dry matter content (DM) of the silage; greater intake associated with greater dry matter content of the silage. Grain increases the DM of a forage. Ward et al. (1966) indicated that grain was valuable for increasing the DM of sorghum silage and its resulting consumption by animals. Hemken et al. (1971) and Hunter (1978) working with corn silage made the same conclusion.

Adding grain to silage or any other forage in order to increase its DM is only useful if a higher feed DM improves animal performance. High DM in silage is essential for proper ensiling with minimum nutrient



losses. In silages, seeds are the major contributors of starch which is utilized by the bacteria during the fermentation process. Morrison (1956) reported that the grain portion of forage corn was digested better (85.5%) than the leaves (61.2%) and the stover (48.2%). Genter (1960) estimated that two-thirds of the total digestible nutrients (TDN) of a corn plant are contained in the ear. These findings show that grain improves the feeding quality of a silage or forage.

There is, however, considerable evidence that no strong relationship exists between grain content and silage or forage quality, as measured by animal performance (milk production and average daily gain). Huffman and Duncan (1956) compared a high-grain variety of corn (Ohio M15) with a low-grain variety (Eureka) and found no differences in FCM yields. When sorghums of low grain-to-stalk ratio were compared with high-grain varieties, weight gains by calves and steers were not significantly different (Garret and Worker, 1965, Meyer et al., 1959, Richardson et al., 1961). In an attempt to evaluate the contribution of sorghum seed, Reames et al. (1961) added or removed the heads in making Atlas (an intermediate-type sorghum) silage. The TDN was not significantly affected in either case. According to Dunn et al. (1954, 1955), TDN of grainless corn silage was about 80 percent of that in regular corn silage. Bratzler et al. (1965) found that silage from male-sterile, high-sugar corn raised in isolation contained 89 percent as much digestible energy as its fertile counterpart. Cows fed sterile corn free-choice produced as much milk as cows receiving

regular corn (McCullough et al. 1964). Hunter (1978) concluded that there was no strong relationship between forage quality and grain content.

Other workers, however, obtained results in contrast to the ones outlined above. Browning et al. (1961) found that cows fed a high-grain sorghum (RS 610) produced higher daily yields of milk than those fed a forage sorghum (NK 300). Dry matter intake was 1.38 kg/100 kg for NK 300, compared to 2.24 kg/100 kg for RS 610. Boren et al. (1962) obtained better beef gains from a fertile hybrid than a sterile hybrid sorghum. Results of Genter (1960), Rutger (1969), and Matsushima (1971) reinforced the idea that increasing the proportion of grain enhances feed quality. Hemken et al. (1971) working with corn silage reported reduced dry matter intake, reduced milk yield and reduced body weight gain when the ears were removed. The effect on body weight was more profound than on milk production.

The inconsistency of results obtained from feeding trials shows that grain content alone is not a good indicator of forage quality, as measured by animal performance. Although variation in dry matter content of forages cut at different stages of maturity is a confounding factor contributing to contradictory feeding trial results, it certainly is not the only one. Helm and Leighton (1960) evaluated lactation response to maturity of Tracy and Hegari sorghum silages and found only small differences. Owen (1965) compared Atlas sorghum silage at four stages of maturity and obtained nearly the same FCM production for all stages. Production was slightly lower, but not

significantly, for the milk and soft-dough stages while dry matter intake was progressively greater for each successive stage. Browning and Lusk (1965) reported significantly greater dry matter intake for RS 610 grain sorghum harvested at the hard-dough stage as compared to the milk and dough stages but there was no appreciable effect on FCM yields. Marshall et al. (1966) compared a high-grain sorghum variety at milk-dough and hard-kernel stages of maturity for two years. In the first year during which the dry matter contents of the silages were 23.1 and 46.6 percent, the consumption of dry matter was 60 percent higher for the more mature, drier silage. However, neither milk production nor body weight changes was significantly influenced in either of the two years. Morgan and Ellzey (1964) fed Beef Builder sorghum silage harvested at boot, milk, and hard-dough stages. They reported less DM intake and FCM yields for the boot stage, but milk and hard-dough stages gave similar results. Boren et al. (1963) reported 8 percent less FCM when Frontier 210, a high-grain sorghum, was ensiled at ten days post-bloom (23.1% DM), compared to later harvest (25.8% DM). The intake of the more mature forage was 40 percent greater. These findings seem to suggest more efficient dry matter use from the immature, high-moisture silage.

Newland et al. (1964), in an effort to improve silage quality, harvested only the center portion of the corn plant, including the ear. The dry matter yield was 73 percent of the amount harvested by conventional methods, and TDN was 25 percent greater, however, steer

weight gains were not as good as for the standard silage plus corn grain.

Playne and Skerman (1964) harvested sweet sorghum (*Saccharine*) at different heights from ground level; (1) standard cutting (whole plant), (2) at 24 inches, and (3) at 60 inches. Cutting at 24 inches increased crude protein content by 13 percent while cutting at 60 inches increased it by 45 percent. Dry matter yield for the 24 inch cutting was 75 percent of the standard cutting, while that for the 60 inch cutting was only 37 percent of the standard. This was found to be an impractical method for improving protein content.

Leighton et al. (1969) compared head-chop sorghum silage to a similar dry ration for lactating dairy cows, and reported greater ( $P < 0.01$ ) milk production, feed costs and weekly weight changes for the dry ration than for head-chop silage. Wagner et al. (1973) evaluated high moisture wheat head-chop with dry rolled wheat, high moisture harvested wheat stored in an oxygen-limiting silo, and high moisture wheat preserved with propionic acid in a wooden bin. Cattle gained more slowly on head-chop than on the other three treatments. High moisture grain preserved in the silo produced greater gain than dry rolled wheat. Wheat head-chop produced poorer gains probably because of the greater roughage content, 34.4 percent, of the total ration compared to 10 percent roughage level on the other three rations.

Lane et al. (1975) compared whole sorghum grain stored as silage to whole sorghum grain (same variety) stored as high moisture and dry ground grain in milk production and digestion trials. Dry ground

sorghum grain produced more solids-corrected milk than the other two rations. Dry matter digestibilities were 74.1, 71.4 and 77.4 percent for whole sorghum grain silage, high moisture sorghum grain, and dry ground sorghum grain, respectively. The greater dry matter digestibility (77.4%) for the dry ground sorghum grain possibly was a result of grinding.

Bolsen et al. (1975) compared four rations: (1) unprocessed (whole) sorghum head silage, (2) rolled sorghum head silage, (3) rolled sorghum head silage plus high-moisture grain, and (4) high-moisture grain plus chopped hay. Steers fed ration 3 gained faster ( $P < 0.05$ ) and more efficiently ( $P < 0.05$ ) than steers fed any of the other three rations.

In summary it can be said that greater grain content increases the dry matter content of silages but does not guarantee improved animal performance. Intake is greater when forage is harvested in the hard-seed stages of maturity compared with earlier stages but feed efficiency is reduced. Establishing the extent to which higher yields from later harvest are neutralized by less efficient use of grain is necessary for devising efficient methods for harvest and feeding grain sorghum.

### EXPERIMENTAL PROCEDURE

Whole plant grain sorghum (above ground only) and grain sorghum heads were chopped and ensiled in upright silos in 1978. Sorghum grain was also harvested and stored in 1978. Feeding comparisons were made between the two silages and the sorghum grain by examining the weight changes, milk production and milk composition (dry matter, fat, protein, ash, and lactose). The silages were rolled at the time of feeding to increase the digestibility of starch and energy (Smith, 1948, Ward et al., 1965). The three treatments were:

- A. Sorghum grain,
- B. Head-chop grain sorghum silage,
- C. Whole plant grain sorghum silage.

The daily rations were as follows:

	Ration		
	A	B	C
	<hr/> (kg/day) <hr/>		
Sorghum grain	7.4		4.1 <sup>a</sup>
Head-chop silage		14.4	
Whole plant silage			12.7
<sup>b</sup> Supplement	3.7	3.7	3.7
Alfalfa hay	<u>10.3</u>	<u>4.1</u>	<u>2.0</u>
	21.4	22.2	22.5

<sup>a</sup>

Ration C which contained whole plant silage was low in grain content, 4.1 kilograms (dry basis) of sorghum grain were added to raise the energy content.

<sup>b</sup>

The supplement was composed of 90.24% soybean meal, 1.75% trace mineral salt, 3.5% calcium phosphate (21% P), 4.1% calcium carbonate, 0.4% vitamin A & D supplement supplying 35,200 IU vitamin A and 17,600 ICU vitamin D<sub>3</sub> per cow per day, and 0.013% EDDI (9.25% ethylene diamine dihydriodide).

Starch contents of the two silages and the sorghum grain were determined by Macrae and Armstrong (1968) method, then the starch content of the sorghum grain was used to estimate grain contents of the silages.

Thirty-six Holstein cows, at least 30 days postpartum, were divided into six groups of six cows each balanced for age of cow. The groups were then randomly assigned to complementary 3 x 3 Latin-squares.

Period	Cow Group					
	1	2	3	4	5	6
I	A	B	C	A	B	C
II	B	C	A	C	A	B
III	C	A	B	B	C	A

The animals were group fed and the 21-day experimental periods consisted of 14 days for adjustment and 7 days for data collection. The experiment lasted for nine weeks.

The cows were fed twice, once in the morning and once in the afternoon. The rations were limited sufficiently so that no feed was refused. The feeds were sampled once in each data collection period for analysis.

The cows were milked twice daily and their yields recorded to the nearest pound (then converted to kilograms). Milk samples from two successive milkings were taken once during each data collection period from each cow, composited, and analyzed for milk fat by

Milko-Tester, protein by Orange G dye method, dry matter by oven drying at 100<sup>o</sup> C, and ash. The cows were weighed on the 14th and 21st days of each feeding period.



## RESULTS AND DISCUSSION

Proximate analyses of the three sorghum feeds, excluding the other ingredients added to make the rations, are presented in Table 1. As expected, the proportion of grain in the silage influenced crude fiber and nitrogen-free extract contents; more grain reflected by greater proportion of the latter and less of the former.

Crude protein was high in all three feeds but it was somewhat diluted by the stalk content of the whole plant silage as reported earlier by Thurman et al., (1960). Ash increased with the proportion of leaves and stalks. Harvesting only the upper portion of sorghum (in this case sorghum heads or just the grain) results in feeds of higher grain content, higher crude protein, and lower crude fiber, agreeing with the reports by Mays and Washko, (1961), and Playne and Skerman, (1964).

Composite proximate analyses of the rations are in Table 2. Pretrial underestimation of the grain content of the head-chop silage resulted in greater grain content, lower crude fiber and higher nitrogen-free extract in ration B than in the other rations. The high protein content of ration A was the result of including both alfalfa hay and the protein supplement required in the other rations and was expected. The trial was designed to evaluate the energy contributions of the rations.

Cow responses to the treatments are presented in Table 3. Milk production was not influenced significantly by treatment. Consistent gains in body weight indicates the adequacy of energy in the rations.

Table 1. Proximate analyses of the sorghum feeds

Dry basis								
	Starch content	Grain content	DM	CP	CF	EE	NFE	ASH
(%)								
Sorghum Silage	66.4	100.0	90.6	14.3	5.0	3.3	74.2	3.2
Head-chop Silage	48.8	73.5	63.4	10.8	11.5	2.5	70.4	4.8
Whole plant Silage	20.3	30.6	42.8	9.3	21.6	2.4	57.8	8.9

Table 2. Composite proximate analyses of the rations

Ration	Grain:forage	DM	Dry matter basis				Ash
			Crude protein	Crude fiber	Ether extract	Nitrogen-free extract	
			(%)				
A	51:49	90.4	21.7	16.0	3.0	50.8	8.5
B	63:37	70.9	17.8	13.5	2.7	58.6	7.4
C	51:49	55.7	16.9	16.5	2.8	54.7	9.1

Table 3. Weight gains and milk production

Ration	DM intake	Milk production (4% FCM)	Body weight gain
		(kg/day)	
A	21.4	19.7 <sup>a</sup>	0.47 <sup>a</sup>
B	22.2	20.3 <sup>a</sup>	0.61 <sup>a</sup>
C	22.5	20.4 <sup>a</sup>	0.49 <sup>a</sup>

<sup>a</sup> Values in the same column with the same superscript are not significantly different ( $P < 0.05$ ). See Table 6 for statistical analysis.

Although there were no significant differences in body weight gains and FCM production among the treatments, whole plant grain sorghum silage and sorghum grain had better grain efficiency for FCM production than head-chop grain sorghum silage. They each required 0.55 kg grain (dry basis) for a kilogram of FCM as compared to 0.67 kg grain per kilogram of FCM for head-chop (Table 4). The results suggest that grain is utilized efficiently only to the point that the cows receive adequate energy to meet their milk production needs and that above a certain ratio of grain-to-forage, efficiency of grain utilization declines. McCullough (1970) reported that the efficiency of energy utilization for cows falls when more than 40 percent grain is fed with silage.

Whole plant silage produced milk with significantly greater fat percentage than head-chop silage, Table 5. Although volatile fatty acids in the silages were not measured in this experiment, those obtained in another experiment using the same silages show that whole plant silage had greater acetic acid (76.5 molar %) concentration than head-chop silage (73.1 molar %). Head-chop silage had a slightly greater concentration of propionic acid (13.9 molar %) than whole plant silage (13.5 molar %). Whole plant silage had a lower pH (4.3) than head-chop silage (4.7), indicating a greater total acid concentration, especially when the difference in moisture content is considered. The greater acetic acid concentration in whole plant silage could account for the greater milkfat percentage obtained (McCullough, 1970). The greater proportion of roughage in whole

Table 4. Feed-to-milk ratios

Ration	DM/FCM	Grain/FCM
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		
<hr/>		

Table 5. Composition of milk

Ration	DM	Fat	Protein	Ash	Lactose
			(%)		
A	<sup>a,b</sup> 12.7	<sup>a,b</sup> 3.6	<sup>a</sup> 3.4	<sup>a</sup> 0.69	<sup>a</sup> 5.0
B	<sup>a</sup> 12.6	<sup>a</sup> 3.5	<sup>a</sup> 3.4	<sup>a</sup> 0.70	<sup>a</sup> 5.0
C	<sup>b</sup> 12.9	<sup>b</sup> 3.7	<sup>a</sup> 3.4	<sup>a</sup> 0.69	<sup>a</sup> 5.1

<sup>a,b</sup> Values in the same column with different superscript are significantly different ( $P < 0.05$ ).

Table 6. Analyses of variance of milk production and body weight change

Source of variation	Degrees of freedom	Milk production		Body weight change	
		Mean square	F-value	Mean square	F-value
Period	2	141.65	13.40 <sup>**1</sup>	874.41	4.72 <sup>*2</sup>
Cow	35	144.46	13.67 <sup>**</sup>	588.28	3.17 <sup>**</sup>
Treatment	2	25.38	2.40 <sup>NS3</sup>	59.73	0.32 <sup>NS</sup>
Error	67	10.57		185.35	
Total	106				

1. Highly significant ( $P < 0.01$ )

2. Significant at 5% level ( $P < 0.05$ )

3. Non significant

4. One cow was sick in the second period therefore its data was not used in the analysis, and the observations used in data set were reduced by one.



plant silage than in head-chop is another factor that may have contributed to greater milkfat percentage for whole plant silage than for head-chop silage, since a high-roughage low-grain diet favors greater proportion of acid in the rumen (Tyznik and Allen, 1951; Van Soest, 1963, Huber et al., 1964, 1966, Davis, 1967, and McCullough, 1970).

Sorghum grain produced milk with lower fat test than, but not significantly different from, that from whole plant silage. The high roughage proportion (which was equal to that of whole plant silage) may have been responsible for narrowing the milkfat percentage gap between these two treatments. The short time on any one treatment emphasizes the significance among milk fat percentages because longer time is usually required to express those differences.

Milk dry matter was significantly higher for whole plant silage than for head-chop silage. It was also higher, but not significantly, than for grain sorghum. These differences are primarily attributable to the differences in milk fat contents. Concentrations of other milk components - protein, ash, and lactose - did not vary significantly among treatments.

The relative economic feasibility of the tested treatments is dependent on the costs of the several ration ingredients. Requirement for nearly 4 kg soybean meal per cow daily raises the ration cost precipitously when soybean meal is expensive relative to other ration ingredients. Certainly alfalfa hay furnishes protein at less cost than does soybean meal under most midwestern price relationships.

Devising an efficient method for harvesting and feeding grain

sorghum requires establishing the trade-off point between higher yields and lower efficiency from later harvest. The task is further complicated by the need to establish the grain-to-forage ratio that results in the highest grain-to-milk ratio. Knowledge of the optimum grain-to-forage ratio for milk production would reduce dairy cattle feed costs by providing for the addition of the correct amount of grain to the forage when preparing the rations.

### SUMMARY AND CONCLUSIONS

Results obtained from a comparison of three rations; one containing silage made from grain sorghum harvested as "head-chop", another containing whole plant grain sorghum silage with added sorghum grain, and a third containing sorghum grain, in a complementary 3 x 3 Latin-square design using thirty-six Holstein cows show that neither milk production nor average daily gain was influenced significantly by treatment. Whole plant silage produced milk significantly higher in dry matter and milkfat than head-chop silage, probably due to differences in grain content and proportions of acetate. Concentrations of other milk components - protein, ash, and lactose - did not vary significantly among treatments.

Conventional fine chopping and ensiling of the entire plant, with some grain added at feeding, is as good as ensiling only the upper portion (head-chop) of the grain sorghum plant, and feeding dry grain.

Although feeds with more grain, more crude protein, and less crude fiber can be produced by using harvesting methods that reduce the stalk percentage of grain sorghum feeds, there seems to be no advantage for such methods of harvest, as far as milk production and average daily gain are concerned. Consequent reduction in dry matter yields per acre of materials produced by such harvesting methods only serves to favor the conventional method of harvest, ensiling the entire plant.

Grain content, per se, is a poor indicator of silage quality, as measured by milk production and average daily gain, but there seems

to be a relationship between grain-to-forage ratio and grain-to-milk ratio. The exact ratios may vary with each individual feeding situation depending on such factors as the level of milk production and the type and quality of forage fed.

# LITERATURE CITED

- Bolsen, K.K., Riley, J.G., and Fink, G. 1975. Milo Head Silage (Milage) Rations for Finishing Yearling Steers. Kansas Agr. Expt. Sta. Rep. Progr. 230, March 7, p. 39.
- Boren, F.W., Brethour, J.R., and Ward, G.M. 1963. Kansas Feeding Trials Using Sorghum Silage. p. 44. Proc. Third Grain Sorghum Research and Utilization Conference, Amarillo, Texas, March 12 - 13.
- Boren, F.W., Smith, E.F., Richardson, D., Fallis, D.L., and Fairbanks, G.E. 1962. Factors Affecting the Nutritive Value of Sorghum Silage. Kansas Agr. Expt. Sta., Bull. 447.
- Bratzler, J.W., King, T.B., and Thomas, W.I. 1965. Nutritive Value of High-Sugar Corn Silage. J. Anim. Sci., 21:1218. (Abstr.).
- Browning, C.B., and Lusk, J.W. 1965. Influence of Maturity at Harvest on Yield and Quality of Grain Sorghum Silage. Mississippi State Univ. Info. Sheet 900.
- Browning, C.B., and Lusk, J.W. 1966. Comparison of Feeding Value of Corn and Grain Sorghum Silages on the Basis of Milk Production and Digestibility. J. Dairy Sci., 49:1511.
- Browning, C.B., Lusk, J.W., and Miles, J.T. 1961. Comparative Feeding Value of Corn and Grain Sorghum Silages. J. Dairy Sci., 44:1205. (Abstr.).
- Browning, C.B., and Merwine, N.C. 1966. What About Grain Sorghum Silages? Hoard's Dairyman, March 25, p. 364.
- Cunningham, W.S., and Reed, J.R. 1927. Japanese Honeydrip Sorghum Silage versus June Corn Silage for Milk Production. Arizona Agr. Expt. Sta., Bull. 122.
- Davis, C.L. 1967. Acetate Production in the Rumen of Cows Fed Either Control or Low-Fiber, High-Grain Diets. J. Dairy Sci., 50:1621.
- Duitsman, W.W. 1978. Kansas Agr. 62nd Annual Report, p. 7.
- Dunn, K.M., Ely, R.E., Huffman, C.F., and Duncan, C.W. 1954. The Value of Snapped-Corn-Ear Silage and Grainless Corn Silage (Ear Removed) for Milk Production. Michigan Agr. Expt. Sta., Quart. Bull. 37:223.
- Dunn, K.M., Ely, R.E., Huffman, C.F., and Duncan, C.W. 1955. The Value of Corn Silage and Recombined Corn Silage in Respect to Milk Production. J. Dairy Sci., 38:58.
- Garret, W.N., and Worker, G.F., Jr. 1965. Comparative Feeding Value of Silage Made from Sweet and Dual-Purpose Varieties of Sorghum. J. Anim. Sci., 24:782.

Genter, C.F. 1960. Corn and Other Crops for Silage in Virginia. Virginia Agr. Expt. Sta., Bull. 516.

Good, E.S., Horlacher, L.J., and Grimes, J.C. 1921. A Comparison of Corn Silage and Sorghum Silage for Fattening Steers. Kentucky Agr. Expt. Sta., Bull. 233.

Helm, R.E., and Leighton, R.E. 1960. Relationship of Stage of Maturity at Harvest to the Feeding Value of Sorghum Silage for Dairy Cows. J. Dairy Sci., 43:868.

Hemken, R.W., Clark, N.A., Goering, H.K., and Vandersall, J.H. 1971. Nutritive Value of Corn Silage as Influenced by Grain Content. J. Dairy Sci., 54:383.

Huber, J.T., and Boman, R.L. 1966. Effect of Grain Level and Protein Content of the Grain for Grazing Cows on Milk Composition and Yield, and Certain Blood and Rumen Constituents. J. Dairy Sci., 49:395.

Huber, J.T., Graf, G.C., and Engel, R.W. 1964. Effect of Supplemental Feeding of Cows on Pasture on Milk Composition and Yield. J. Dairy Sci., 47:63.

Huffman, C.F., and Duncan, C.W. 1956. Comparison of Silages Made from Field Corn (Ohio M15) and Silage Corn (Eureka) for Milk Production. J. Dairy Sci., 39:998.

Hunter, R.B. 1978. Selection and Evaluation Procedures for Whole-Plant Corn Silage. Can. J. Plant Sci., 58:66.

La Master, J.P., and Morrow, K.S. 1929. Corn Silage versus Sweet Sorghum Silage for Milk Production. South Carolina Agr. Expt. Sta., Bull. 254.

Lane, G.T., Rupp, R.A., Leighton, R.E., Lichtenwalner, R.E., Sullins, R.D., and Rooney, L.W. 1975. Digestibility of Whole Sorghum Grain Stored as Silage or High Moisture Grain. J. Dairy Sci., 58:762. (Abstr.).

Leighton, R.E., Rao, S., and Helm, R.E. 1969. Comparison of Head-Chop Silage to a Similar Dry Ration for Lactating Dairy Cows. J. Dairy Sci., 52:935. (Abstr.).

Macrae, J.C., and Armstrong, D.G. 1968. Enzyme Method for Determination of  $\alpha$ -Linked Glucose Polymers in Biological Materials. J. Sci. Fd. Agric., 19:578.

Marshall, S.P., Norden, A.J., Ross, I.J., and Meyers, J.M. 1966. Effect of Maturity and Ensiling Procedure on Feeding Value of Sorghum Silage. J. Dairy Sci., 49:448. (Abstr.).

Matsushima, J.K. 1971. Quality Factors in Corn and Sorghum Silage. 26th Annual Corn and Sorghum Res. Conf. Amer. Seed Trade Assoc. Washington, D.C.

Mays, D.A., and Washko, J.B. 1961. Cutting and Grazing Management for Sudan Grass and Pearl Millet. Pennsylvania Agr. Expt. Sta., Bull. 682.

McCullough, M.E. 1970. Silage Research at the Georgia Station. Georgia Agr. Expt. Sta., Rep., 75.

McCullough, M.E., Sisk, L.R., and Settl, O.E. 1964. Influence of Silage Dry Matter Intake on Efficiency of Milk Production. J. Dairy Sci., 47:650.

Meyer, J.H., Lofgreen, G.P., and Ittner, N.R. 1959. Alfalfa and Sorghum Silages. California Agr., 13(1):4.

Morgan, E.B., and Ellzey, H.D. 1964. Silage for Higher Milk. Louisiana Agr., 7(3):10.

Morrison, F.B. 1956. Feeds and Feeding. 22nd Ed. The Morrison Publishing Co., Clinton, Iowa.

Nevens, W.B., and Kendall, K.A. 1954. Sorghums and Soybeans as Silage Crops for Milk Production. Illinois Agr. Expt. Sta., Bull. 578.

Newland, H.W., Brown, W.K., Deans, R.J., Hansen, C.M., and Comstock, I.W. 1964. Center-Cut Corn Silage: A Complete Energy Feed for Fattening Cattle. Michigan Agr. Expt. Sta. Quart. Bull. 46:374.

Owen, F.G. 1965. Supplemental Dehydrated Alfalfa Pellets (DEHY) in Normal and High-Grain Rations. J. Dairy Sci., 48:817.

Owen, J.R., Miles, J.T., Cowser, W.C., Lusk, J.W., Custer, E.W., and Cardwell, J.T. 1961. Feeding Value of Corn and Sorghum Silage for Milk Production. J. Anim. Sci., 20:288.

Playne, M.J., and Skerman, P.J. 1964. Influence of Height of Cutting on Yield, Nitrogen Content and Ensilage of Sweet Sorghum. Empire J. Exptl. Agr. 32:325.

Reames, C.E., Stallcup, O.T., and Thurman, R.L. 1961. A Comparison of the Digestibility of Atlas Sorgho Silages with Corn Silage. J. Dairy Sci., 44:693.

Richardson, D., Smith, E.F., Boren, F.W., and Koch, B.A. 1961. Grain Sorghum Silage versus Forage Sorghum Silage; Dehydrated Alfalfa versus Vitamin A and the Value of Aureomycin in Cattle Rations. Kansas Agr. Expt. Sta., Circ. 383.

Rutger, J.N. 1969. Relationship of Corn Silage Yields to Maturity. Agron. J. 61:68.

- Smith, E.F. 1948. Effect on Grinding on the Nutritive Value of Grain Sorghums for Fattening Steer Calves. Kansas Agr. Expt. Sta., 34th Annual Rep., p. 33.
- Thurman, R.L., Stallcup, O.T., and Reames, C.E. 1960. Quality Factors of Sorgho as a Silage Crop. Arkansas Agr. Expt. Sta., Bull. 632.
- Tyznik, W., and Allen, N.N. 1951. The Relationship of Roughage Intake to the Fat Content of the Milk and the Level of Fatty Acids in the Rumen. J. Dairy Sci., 34:493. (Abstr.).
- Van Soest, P.J. 1963. Ruminant Fat Metabolism with Particular Reference to Factors Affecting Low Milk Fat and Feed Efficiency. A Review. J. Dairy Sci., 46:204.
- Wagner, D.G., Don Croka and Martin, T. 1973. High Moisture Harvested Wheat and Wheat Head-Chop for Finishing Cattle. Oklahoma State Univ. Agr. Expt. Sta. Report MP - 90.
- Wall, J.S., and Ross, W.M. 1970. Sorghum Production and Utilization. Avi. Publishing Co. Inc. West Port, Connecticut.
- Ward, G.M., Boren, F.W., and Smith, E.F. 1966. Relation Between Dry Matter Content and Dry Matter Consumption of Sorghum Silage. J. Dairy Sci., 49:399.
- Ward, G.M., Narasimhalu, P.R., Boren, F.W., Schneider, V.L., and Fairbanks, G.E. 1965. Effect of Grinding Forage Sorghum Heads on Silage Starch and Energy Digestibility. J. Dairy Sci., 48:1537.



COMPARISON OF WHOLE PLANT GRAIN SORGHUM SILAGE, GRAIN SORGHUM  
HEAD-CHOP SILAGE, AND SORGHUM GRAIN IN RATIONS FOR LACTATING COWS

by

MOSES TIMOTHY DAURA

B. S., University of Zambia, 1977

---

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1980

## ABSTRACT

Three rations; one containing silage made from grain sorghum harvested as "head-chop", another containing whole-plant grain sorghum silage with added sorghum grain, and a third containing sorghum grain and alfalfa hay, all supplemented with soybean meal, minerals, and vitamins were compared in a lactation trial with thirty-six Holstein cows. A complementary 3 x 3 Latin-square design with 14-day adjustment period and 7-day data collection period was used.

On a per cow basis the average daily dry matter intake, 4 percent fat corrected milk production, and weight gain for the three treatments were: head-chop silage, 22.2 kg, 20.3 kg and 0.61 kg; whole plant silage, 22.5 kg, 20.4 kg and 0.49 kg; sorghum grain, 21.4 kg, 19.7 kg and 0.47 kg, respectively. The differences in milk production and weight changes were not significant.

Milk composition (dry matter, fat, protein, ash, and lactose) for the three treatments were: head-chop silage, 12.6%, 3.5%, 3.4%, 0.70%, and 5.0%; whole plant silage, 12.9%, 3.7%, 3.4%, 0.69%, and 5.1%; sorghum grain, 12.7%, 3.6%, 3.4%, 0.69%, and 5.0%, respectively. Whole plant silage produced milk significantly higher in dry matter and milkfat than head-chop silage ( $P < 0.05$ ), probably due to differences in grain content and proportions of acetate.